ON THE CULTURE OF THE OBSERVING POWERS OF CHILDREN

E. A. YOUMANS & J. PAYNE

THE

CULTURE OF THE OBSERVING POWERS OF CHILDREN.

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AN ESSAY ON THE

CULTURE OF THE OBSERVING POWERS OF CHILDREN,

ESPECIALLY IN CONNECTION WITH

THE STUDY OF BOTANY.

BY

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OF NEW YORK.

EDITED, WITH NOTES AND A SUPPLEMENT ON THE EXTENSION OF THE PRINCIPLE TO ELEMENTARY INTELLECTUAL TRAINING IN GENERAL,

BY

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'You study Nature in the house, and when you go out of doors you cannot find her.'—PROFESSOR AGASSIZ.

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1872.

PREFACE

TO

THE ENGLISH EDITION.

THE EDITOR'S ACQUAINTANCE with the valuable treatise which he now brings before the English public, is of recent date. He had undertaken to write a brief paper for the Leeds Meeting of the Social Science Association, on 'The Teaching of Elementary Science as a Part of the Earliest Instruction of Children;' and had completed the arguments and illustrations by which he endeavoured to show that, in the true order of things, the earliest formal instruction of children should be a *continuation* of that which they had already unconsciously received from Nature and Fact, when Dr. Youmans, of New York, put into his hands the 'First Book of Botany,' and the little treatise, which is here republished, 'On the Culture of the Observing Powers of Children,' written by Miss Youmans. He was at once struck with the remarkable correspondence between the views taken by Miss Youmans and those which

he had presented in his own paper, and proportionally interested in the fact that these views had been realised in successful practice. It therefore occurred to him that he should be doing a service to the cause of education by bringing them under the notice of English teachers, and of all who take an interest in the improvement of elementary instruction. He has a profound conviction—which many others share with him—that what is demanded by the present times is not so much extended machinery as better teachers—teachers more thoroughly acquainted with the nature of the mind with which they are professedly dealing, and capable of making their knowledge of the processes of education more productive in results; and, moreover, that the improved teaching which is needed, must begin at the beginning. As things are, we adopt conventional opinions respecting the essentials of instruction—frequently confounding the means with the end—and entrust the most delicate and difficult part of the process—the early development and training of the mind—to teachers who have no other idea of teaching than that it is a sort of mechanical grinding, which is somehow or other to produce the desired result. We all recognize the usual product of such grinding in countless examples of children exposed to it, who grow up to manhood and pass their lives in the possession of eyes that do not see, ears that do not hear, and minds that

have never been taught to think. The teaching, however, which ends in such results as these is, to speak strictly, no teaching at all.

It fails altogether as an agency for quickening intelligence through the acquisition of knowledge. The teacher has not done what he engaged to do. He professed to be an artist aiming to secure, through the resources of his art, a definite end; that end he has not secured. He undertook—what nature left alone does not undertake—to teach his pupils not only to think, but to think with a fixed purpose in view; not only to set their minds in motion, but to direct that motion so as to make it effectual for (1) the acquisition of exact knowledge, (2) the formation of good mental habits, (3) and consequently, the attainment of a consciousness of power applicable to all cases of mental action. His work has proved inefficient in all these respects, and he has therefore failed in the very object of his existence.

The didactic method—the method of endless telling, explaining, thinking for the pupil, and ordering him to learn—has had its day. It is, then, worth while to consider whether it may not be superseded by one which recognizes the native ability of the human mind, under competent guidance, to work out its own education by means of its own active exercise.

Miss Youmans' method, by providing for the exercise

of the pupil's own mind on concrete facts, which are to be observed, investigated, judged of, and described by himself, is an obvious recognition of this principle; and in carrying it out she supersedes 'the usual desultory practice of object-teaching in noting the disconnected properties of casual objects,' by 'training him (to use her own words) not only to observe the sensible facts, but constantly to put them into those relations of thought by which they become organized knowledge.'

In general, then, the purpose of this little book is to give the elementary teacher an enlarged and enlightened view of his proper functions, to fix attention on principles rather than routine, to supersede didactic cramming by systematic mental training; and, in short, to place the noble art of teaching upon a solid foundation.

The editor has added a few notes by way of enforcing the author's general argument, and in his 'Supplement' has endeavoured to illustrate a principle to which he attaches great importance, as the key-note to the art of teaching; namely, that the process by which the pupil learns being essentially one of subjective, conscious, self-instruction, the teacher's counterpart, conscious objective process, ought always to recognize this fact; that, in short, only in proportion as the teacher aids, without superseding, the pupil's own efforts to teach himself, will he be successful in his teaching.

From a conviction, moreover, that the study of a descriptive science like Botany does not sufficiently develope the instinct for experiment, nor supply a training in the doctrine of forces, he has shown, by a typical lesson, how the elements of mechanics may be learnt by young children through their own observation and experiments, without explanations from the teacher—the learners being considered in the light of investigators, seeking to ascertain at first hand facts and their interpretation.

4, Kildare Gardens, W.
May 1, 1872.

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THE CULTURE

OF

THE OBSERVING POWERS OF CHILDREN,

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THE PRESENT WORK is the outgrowth of a desire to gain certain advantages in general mental culture which can be only obtained by making Nature a more direct and prominent object of study in primary education than is now done.

The subject of Mind has various aspects; that in which the teacher is chiefly concerned is its aspect of *growth*; I propose to consider the subject from this point of view: to state, first, some of the essential conditions of mental unfolding; then to show in what respects the prevailing school-culture fails to conform to them; and, lastly, to point out how the subject of Botany, when properly pursued, is eminently suited to develope those forms of mental activity the neglect of which is now the fundamental deficiency of popular education.

Mind is a manifestation of life; and mental growth is dependent upon bodily growth. In fact, these operations not only proceed together, but are governed by the same laws.

As body, however, is something more tangible and definite than mind, and as material changes are more easily apprehended than mental changes, it will be desirable to glance first at what takes place in the growth of the body.

I.—HOW THE BODY GROWS.

All living beings commence as germs. The germ is a little portion of matter that is uniform throughout, and is hence said to be *homogeneous*.

The beginning of growth is a change in the germ, by which it is separated into unlike parts. One portion becomes different from the rest, or is *differentiated* from it; and then it is itself still further changed or differentiated into more unlike parts. In this way, from the diffused uniform mass, various tissues, structures, and organs gradually arise, which, in the course of growth, constantly become more diverse, complex, and *heterogeneous*. But, accompanying these changes, there is also a tendency to *unity*. It is by the assimilation of like with like that differences arise. Nourishment is drawn in from without, and then each part attracts to itself the particles that are like itself. Bone material is incorporated with bone, and nerve material with nerve; so that each different part arises from the grouping together of similar constituents. This tendency to unity, by which each part is produced, and by which all the parts are wrought together into a mutually dependent whole, is termed *Integration*; and the combined operations by which development is carried on constitute what is now known as *Evolution*.

At birth, bodily development has been carried so far that the infant is capable of leading an independent life. Mental

growth commences when the little creature begins to be acted upon by *external agencies*. An already-growing mechanism takes on a new kind of action in new circumstances, and body and mind now grow together. The development of mind depends upon certain properties of nervous matter by which it is capable of receiving, retaining, and combining impressions. An organism has been thus prepared, upon which the surrounding universe takes effect, and the growth of mind consists in the development of an internal consciousness in correspondence to the external order of the world.

II.—HOW THE MIND GROWS.

At birth we say the infant *knows* nothing; that is, it recognises *no thing*. Though the senses produce perfect impressions from the first, yet these impressions are not distinguished from each other. This vague, indefinite, homogeneous sensibility or feeling may be called the germ-state of mind. As bodily growth begins in a change of the material germ, so mental growth begins in a change of feeling. This change of feeling is due to a change of external impressions upon the infant organism. Were there no changes of impression upon us, there could never be changes of feeling within us, and *knowing* would be impossible. If, for example, there were never an alteration of temperature, and a resulting change of impressions upon the nerves, we should be for ever prevented from knowing anything of *heat*. The first dawn of intelligence consists in changes of feeling by which *differences* begin to be recognised. Mind commences in this perception of differences; it cannot be said that we know any thing *of itself*, but only the differences between it and other things. And,

as in bodily growth, so in mental growth, there is an assimilation of like with like, or a process of *integration*. From the very first, along with the perception of difference, there has been also a perception of likeness. The clock-stroke, when first heard, is felt simply as an impression *differing* from others that precede and succeed it in the consciousness; but, when heard again, not only is there this recognition of difference, but it is perceived as *like* the clock-stroke which preceded it. This second impression is assimilated to the first, and, when a third arises, it also coalesces with the former like impressions. And so of all other sights, sounds, and touches. Under the influence of constant changes of impression, and a constant assimilation of like with like, there arise, at first vague, and then distinct unlikenesses among the feelings; that is, sights begin to be distinguished from sounds, and sounds from touches, while, at the same time, differences begin to be perceived among the impressions of each sense. In this way, the consciousness, at first homogeneous, grows into diversity, or becomes more *heterogeneous*, while its separated or differentiated parts are termed *ideas*.

Let us look into this a little more closely. When an infant opens its eyes for the first time upon the flame of a candle, for example, an image is formed, an impression produced, and there is a change of feeling. But the flame is not known, because there is as yet no *idea*. The trace left by the first impression is so faint that, when the light is removed, it is not remembered; that is, it has not yet become a mental possession. As the light, however, flashes into its eyes a great many times in a few weeks, each new impression is added to the trace of former impressions left in the nervous matter, and thus the impression deepens, until it becomes so strong

as to remain when the candle is withdrawn. The idea therefore grows by exactly the same process as a bone grows; that is, by the successive incorporation of like with like. By the integration of a long series of similar impressions, one portion of consciousness thus becomes differentiated from the rest, and there emerges the *idea* of the flame. Time and repetition are therefore the indispensable conditions of the process.[1]

Now, when the candle is brought, the child recognises or knows it; that is, it perceives it to be *like* the whole series of impressions of the candle-flame formerly experienced. It knows it because the impression produced agrees with the idea. In this way, by numerous repetitions of impressions, the child's first ideas arise; and, in this way, all objects are known. We know things, because, when we see, hear, touch, or taste them, the present impression spontaneously blends with like impressions before experienced. We know or recognise an external object not by the single impression it produces, but because that impression revives a whole train or group of previous discriminations that are like or related to

[1] The single taste of sugar, by repetition, impresses the mind more and more, and, by this circumstance, becomes gradually easier to retain in idea. The smell of a rose, in like manner, after a thousand repetitions, comes much nearer to an independent ideal persistence than after twenty repetitions. So it is with all the senses, high and low. Apart altogether from the association of two or more distinct sensations, in a group or in a train, there is a fixing process going on with every individual sensation, rendering it more easy to retain when the original has passed away, and more vivid when by means of association it is afterwards reproduced. This is one great part of the education of the senses. The simplest impression that can be made of taste, smell, touch, hearing, sight, needs repetition in order to endure of its own accord; even in the most persistent sense—the sense of seeing—the impressions on the infant mind that do not stir a strong feeling will vanish as soon as the eye is turned some other way.—*Professor Bain.*

it; while the number of those that are called up is the measure of our intelligence regarding it. If something is seen, heard, felt, or tasted, which links itself to no kindred idea, we say 'we do not know it;' if it partially agrees with an idea, or revives a few discriminations, we know something about it, and the completer the agreement the more perfect the knowledge.

As to know a thing is to perceive its differences *from* other things, and its likeness *to* other things, it is therefore strictly an act of *classing*. This is involved in every act of thought, for to recognise a thing is to classify its impression or idea with previous states of feeling. Classification, in all its aspects and applications, is but the putting together of things that are alike—the grouping of objects by their resemblances; and as to know a thing is to know that it is *this* or *that*, to know what it is like and what it is unlike, we begin to classify as soon as we begin to think. When the child learns to know a tree, for example, he discriminates it from objects that differ from it, and identifies it with those that resemble it; and this is simply to class it as a tree. When he becomes more intelligent regarding it—when, for instance, he sees that it is an elm or an apple-tree—he simply perceives a larger number of characters of likeness and difference.

How our *degrees* of knowledge resolve themselves into successive classifications has been well illustrated by Herbert Spencer. He says: 'The same object may, according as the distance or the degree of light permits, be identified as a particular negro; or, more generally, as a negro; or, more generally still, as a man; or, yet more generally, as some living creature; or most generally, as a solid body; in each of

which cases the implication is, that the present impression is like a certain order of past impressions.'

In early infancy, when the mind is first making the acquaintance of outward things, mental growth consists essentially in the production of *new ideas* by repetition of sensations, although such ideas never rise singly, but are always linked together in their origin. But, when a stock of ideas has been formed in this manner, the mental growth is mainly carried forward by new *combinations* among them. The simpler ideas once acquired, the development of intelligence consists largely in associating them in new relations and groups of relations. The perception of likeness and difference is the essential work that is going on all the time, but the comparisons and discriminations are constantly becoming more extensive, more minute, and more accurate. A number of elementary ideas thus become, as it were, fused or consolidated into one complex idea; and, by a still further recognition of likeness and difference, this is classed with a new group, and this again with still larger clusters of associated ideas.

The conception of an orange, for example, is compounded of the elementary notions of colour, form, size, roughness, resistance, weight, odour, and taste. These elements are all bound up in one complex idea. The idea of an apple, a pear, a peach, or a plum, is in each case made up of a different group of component ideas, while the notion of a basket of different fruits is a cluster of these groups of still higher complexity, but still represented in thought as one complex idea, the elements of which are united by the relations of contrast and resemblance. Or, again, the child may begin with a large, vague idea, as a tree, for example, and then, as intelligence concerning it progresses, he decomposes it into its component

ideas, as trunk, branches, leaves, roots, and these into still minuter parts. There is a growing mental heterogeneity through the increasing perception of likeness and difference. Thus, as soon as ideas are formed, they begin to be used over and over, and this process is ever continued.[1] An old idea in a new relation or grouping has a new meaning—becomes a new fact or a new truth. The perception of new resemblances and of new differences gives rise to new groupings and new classings of ideas, and thus the mind grows into a complex and highly differentiated organism of intelligence, in which the internal order of thought-relations answers to the external order of relations among things.

That which occurs at this earliest stage of mental growth is exactly what takes place in the *whole course* of unfolding intelligence. Simple as these operations may seem, and begun by the infant as soon as it is born, in their growing complexities, they constitute the whole fabric of the intellect. What we term the 'mental faculties' are not the ultimate elements of mind, but only different modes of the mental activity; and, as one law of growth evolves all the various organs and tissues of the bodily structure, so one law of growth evolves all the diversified 'faculties' of the mental structure. Under psychological analysis, the operations of reason,

[1] Our reason consists in using an old fact in new circumstances, through the power of discerning the agreement; this is a vast saving of the labour of acquisition; a reduction of the number of original growths requisite for our education. When we have anything new to learn, as a new piece of music, or a new proposition in Euclid, we fall back upon our previously-formed combinations, musical or geometrical, so far as they will apply, and merely tack certain of them together in correspondence with the new case. The method of acquiring by patch-work sets in early, and predominates increasingly.—*Bain.*

judgment, imagination, calculation, and the acquisitions of the most advanced minds, yield at last the same simple elements—the perceptions of likenesses and differences among things thought about; while memory is simply the power of *reviving* these distinctions in consciousness. Whatever the object of thought, to know in what respects it differs from all other things, and in what respects it resembles them, is to know all about it—is to exhaust the action of the intellect upon it. The way the child gets its early knowledge is the way *all* real knowledge is obtained. When it discovers the likeness between sugar, cake, and certain fruits, that is, when it integrates them in thought as *sweet*, it is making just such an induction as Newton made in discovering the law of gravitation, which was but to discover the likeness among celestial and terrestial motions. And as with physical objects, so also with human actions. The child may run around the house and play with its toys ; it must not break things or play with the fire. Here, again, are relations of likeness and unlikeness, forming a basis of moral classification. The judge on the bench is constantly doing the same thing; that is, tracing out the likenesses of given actions, and classing them as right or wrong.

Having thus formed some idea of how mental growth takes place, let us now roughly note how far it proceeds in the first three or four years of childhood.

III.—EXTENT OF EARLY MENTAL GROWTH.

From the hour of birth, through all the waking moments, there pour in through the eye ever-varying impressions of light and colour, from the dimness of twilight to the utmost

solar refulgence, which are reproduced as a highly-diversified luminous consciousness. Impressions of sound of all qualities and intensities, loud and faint, shrill and dull, harsh and musical, in endless succession, enter the ear, and give rise to a varied auditory consciousness. Ever-changing contrasts of touch acquaint the mind with hard things and soft, light and heavy, rough and smooth, round, angular, brittle, and flexible, and are wrought into a knowledge of things within reach. And so, also, with the senses of taste and smell. This multitude of contrasted impressions, representing the endless diversity of the surrounding world, has been organised into a connected and coherent body of knowledge.

After two or three years the face that was at first blank becomes bright with the light of numberless recognitions. The child knows all the common objects of the house, the garden, and the street, and it not only knows them apart, but it has extended its discriminations of likeness and difference to a great many of their characters. It has found out about differences and resemblances of form, size, colour, weight, transparency, plasticity, toughness, brittleness, fluidity, warmth, taste, and various other properties of the solid and liquid substances of which it has had experience. It has noted peculiarities among many animals and plants, and the distinctions, traits, and habits of persons.

Besides this, it has learned to associate names with its ideas; it has acquired a language. The number of words it uses to express things and actions, and qualities, degrees, and relations among these things and actions, shows the extent to which its discriminations have been carried. Groups of ideas are integrated into trains of thought, and words into corre-

sponding trains of sentences to communicate them.[1] Nor is this all. There is still another order of acquisitions in which the child has made remarkable proficiency. The infant is endowed with a spontaneous activity: it moves, struggles, and throws about its limbs as soon as it is born. But its actions are at first aimless and confused. As it knows nothing, of course, it can *do* nothing; but, with the growth of distinct ideas and feelings, there is also a growth of special movements in connection with them. It has to find out by innumerable trials how to creep, to walk, to hold things, and to feed itself. To see an object and to be able to seize it, or to go and get it, result from an adjustment of visual impressions with muscular movements, which it has taken thousands of experiments to bring under control. The vocal apparatus has been brought under such marvellous command that hundreds of different words are uttered, each requiring a different

[1] The method by which children acquire their mother-tongue is very suggestive to the thoughtful teacher. They employ analysis before synthesis, they learn before they practise, and then they learn by practising. The sentences uttered in their hearing at first impress the sense of the child with nothing more than a confused noise. But discrimination soon succeeds. The sentence 'shut *the door*' conveys at first no idea of speech. But soon the eye aids the ear, and the mind interprets. The child hears also 'open *the door*,' 'go to *the door*,' &c., and sees the resulting action. The mind then instinctively analyses these phrases, and abstracts from them the common element '*door*,' which is henceforth recognised as the name of the object. Again, after hearing '*shut* the door,' '*shut* the window,' '*shut* the box,' &c., he makes a similar analysis, and recognises '*shut*' as the name of an action performed in his sight. Thus far analysis; then the instinct of imitation comes into play; the child attempts to do with his organs of speech what others do, and after many experiments succeeds, not only in uttering the words, but in applying them correctly. Both Jacotot (*Enseignement Universel*) and Prendergast (*Mastery Series*) employ this natural principle in their methods of teaching language—recognising the sentence as the true unit of speech.—EDITOR.

combination of movements of the chest, larynx, tongue, and lips. Numerous aptitudes and dexterities are achieved, and, when, stimulated by curiosity, it examines its toy and breaks it open to find 'what makes it go,' it has entered upon a career of active experiment, as truly as the man of science in his laboratory.[1]

IV.—NATURE'S EDUCATIONAL METHOD.

Such is Nature's method of education, and such its earliest results. Human beings are born into a world of stubborn realities; of laws that are fraught with life and death in their inflexible course. What the new-born creature shall be taught is too important to be left to any contingency, and so Nature takes in hand the early training of the whole human race, and secures that rudimentary knowledge of the properties of things which is alike indispensable to all. It is, however, only the obvious characters and simpler relations of objects which are thrust conspicuously upon the attention that are recognised in childhood. But the method of bringing

[1] 'Give an infant a beautiful flower. Its bright colour at once attracts his eye; but only for a moment. He does not dwell upon it: his æsthetic taste is not yet awakened. But his instinct for making experiment is in full exercise. He wants to ascertain what other properties the flower has, and especially its property of resistance. He ruthlessly pulls it to pieces, petal from petal, not, as some foolish people imagine, because he delights in destruction, but to make himself acquainted with its mechanical properties, and he is proportionately charmed when he finds that it yields to the power he puts forth. 'Delights in destruction!' Why, he is doing, in his way, in proportion to his knowledge, the very thing that advanced philosophers do in their scientific analyses. He is merely working as an industrious pupil in that school of Nature and Fact in which every human being receives his earliest lessons.'—*Paper read at Leeds by the Editor.*

out mind has been established. Nature's early tuition has given shape to the mental constitution, and determined the conditions and order of its future development. The child is sent to school—the school of experience—as soon as it is born, and Nature's method of leading out the intelligence is that of *growth*. She roots mental activity in organic processes, and thus *times* the rate of acquisition to the march of organic changes. She is never in haste, but always at work; never crams,[1] but ever repeats, assimilates, and organises. Her policy of producing vast effects by simple means is not departed from in the realm of mind; indeed, it is more marvellous here than

[1] The practice of cramming is antagonistic to all true mental development. It is, in fact, the unlawful appropriation of the results of other people's labours. In real education, the result, however imperfect, should be the pupil's own—the outcome of mental acts that he has performed himself. The observation by which knowledge is gained, the experiments by which it is practically applied and made the means of gaining more, should be the pupil's own observation and experiments. Many teachers theoretically opposed to cramming, virtually sanction it by requiring the pupil in the earliest stage of instruction to learn by heart arithmetical tables, formulæ, paradigms, rules, definitions of words from dictionaries, &c., all of which are the results of other people's thinking, not the pupil's own. *After*, but not *before*, the pupil's mind has been exercised on the facts which these classifications and generalisations represent; after he has learnt to classify and generalise himself, he may lawfully appropriate and commit to memory the more apt and concise expressions of others, for they will then become his own. 'To give the net product of enquiry,' says Herbert Spencer (*Education, Intellectual, Moral, and Physical,*' p. 51), 'without the enquiry that leads to it, is found to be both enervating and inefficient. General truths, to be of due and permanent use, must be earned. "Easy come, easy go" is a saying as applicable to knowledge as to wealth. While rules, lying isolated in the mind—not joined to its other contents as outgrowths from them—are continually forgotten; the principles which these rules express piecemeal, become, when once reached by the understanding, enduring possessions.' Hence we see that cramming in education is not only unlawful but inexpedient—not only a crime, but a blunder.—EDITOR.

anywhere else. While the organic world is made up almost entirely of but four chemical elements, the intellectual world is constituted wholly of but *two* ultimate elements, the perception of likeness and the perception of difference among objects of thought. These elements are wrought into the mental constitution through the direct observation and experience of things. Mind is called forth by the spontaneous interaction of the growing organism and the agencies and objects of surrounding Nature.

The school-period at length arrives, and Art comes forward to assume the direction of processes that Nature has thus far conducted. But her course is plainly mapped out; the work begun is to be continued. New helps and resources may be needed, but the end and the essential means should be the same. Mental growth is to be carried by cultivation to still higher stages, but by the same processes hitherto employed. The discriminations of likeness and difference by which all things are known, the comparison, classification, and association of ideas in which knowledge arises, are to become more accurate, more extensive, and more systematic. To do this the mind is to be maintained in living contact with the realities which environ it, but which are now to be regularly studied. We have here the clear criterion by which educational systems must be judged; how does the prevailing practice answer to the test?

V.—DEFICIENCY OF EXISTING SCHOOL-METHODS.

Nothing is more obvious than that the child's entrance upon school-life, instead of being the wise continuation of processes already begun, is usually an abrupt transition to a new,

artificial, and totally different sphere of mental experience. Although, in the previous period, it has learned more than it ever will again in the same time, and learned it according to the fundamental laws of growing intelligence, yet the current notion is, that education *begins* with the child's entrance upon school-life.[1] How erroneous this is we have sufficiently seen. That which does begin at this time is not *education*, but simply the acquirement of new helps to it. The first thing at school is usually the study of words, spelling, reading, and writing—that is, to get the use of written language.[2] This is, of course,

[1] 'After Nature has given her elementary lessons, the ordinary teacher, assuming the position of Nature's deputy, takes the child in hand, and, as we usually say, *begins* his education; that is, arranges a system of means and agencies, on the assumption that he is to begin the child's education, forgetting or not knowing that this education was begun at the child's birth, and is already far advanced. Such a teacher, taking no note of what the child learnt at *the last school*, and not appreciating the method by which he was taught there, devises an entirely independent method of his own, having no necessary connection with that already so successfully employed. When the time comes, that the organic relation between the art and the science of education—the science that accounts for and gives laws to the processes of the art—is properly understood, it will be seen that elementary education, to be effectual, must be a *continuation* of the method already commenced, recognising the principles and directed to the objects which have laid the foundation of all the knowledge which the child, when he becomes the pupil of the professed teacher, already possesses.'—*Paper read at Leeds by the Editor.*

[2] There is little doubt that much of the stupefying of children *by means* of their education is due to the manner in which reading, writing, and arithmetic are usually taught. As soon, however, as it is generally acknowledged that teaching is only another name for mental training, better methods will be adopted, and it will then be also acknowledged that the earliest development of the child's mental powers is a fit occupation for the most accomplished adept in education. This principle was recognised in the Jesuits' notions of teaching, according to which those teachers only were allowed to undertake the primary instruction who had proved their aptness in teaching the higher classes. The reason is obvious. Education being

important and indispensable. To be able to accumulate, compare, arrange, and preserve ideas, and put them to their largest uses, it is necessary to *mark* them. Words are these marks or signs of ideas, and, as such, have an inestimable value. Words, as the marks of ideas, are the representatives of knowledge, and books which contain them become the invaluable depositories of the world's accumulating thought. It is exactly because of their great importance and their intimate relations to our intellectual life, that we should be always vividly conscious of their exact nature and office.

But words are not ideas, they are only the *symbols* of ideas; language is not knowledge, but the *representative* of it.[1] Labels have a value of convenience, which depends upon the intrinsic value of what they point out. Now, there is a constant and insidious tendency in education to invert these relations—to exalt the husk above its contents, the tools above their work, the label above its object, words above the things

the art of developing and forming the mind, and the success of the entire process being mainly dependent on the habits formed in the earliest stage, it is justly considered that, whatever may be done subsequently, at this point of the course especially all the resources of the art are needed. It is difficult to believe that the lamentable average result of elementary instruction in our own primary schools, even under certificated masters, is not due to inefficient methods of teaching. Jacotot has shown that reading may be so taught as to be a means of mental training as well as instruction (see the process as described by the editor, in his lecture on 'Educational Methods,' published by the College of Preceptors), and Mr. Lake, in his ingenious lecture on 'The Application of Mental Science to Teaching, and especially to Teaching Writing' (*Educational Times*, August 1871), has shown, that even that mechanical art may be made a means of real mental training to the pupil. Every act of teaching, indeed, is a mode of dealing with mind, and will be successful only in proportion as this fact is recognised.—EDITOR.

[1] 'En quelque étude que ce puisse être, sans l'idée des choses représentées, les signes représentants ne sont rien.'—ROUSSEAU, *Émile.* (EDITOR.)

for which they stand. The *means* of culture thus become the *ends* of culture, and education is emptied of its substantial purpose. In the lower institutions, while that acquisition and organisation of ideas in which education really consists are neglected, to spell accurately, to read fluently, to define promptly, and to write neatly, are the ideals of school-room accomplishment. In the higher institutions, this ideal expands into the proficient command of a multitude of words, and skill in the arts of expression, so that the student piles language upon language until he has tagged half a dozen labels to each of his scanty, and ill-conceived ideas.

The glaring deficiency of our popular systems of instruction is, that words are not subordinated to their real purposes, but are permitted to usurp that supreme attention which should be given to the *formation of ideas by the study of things.* It is at this point that true mental growth is checked, and the minds of children are switched off from the main line of natural development into a course of artificial acquisition, in which the semblance of knowledge takes the place of the reality of knowledge.

We have seen that *the growth of mind results from the exercise of its powers upon the direct objects of experience,* and consists in its recognition of distinctions among the properties and relations of things, and in the classing and organisation of ideas thus acquired.[1] These operations can be facilitated by the use of words and books, but only when the ideas themselves are first clearly conceived as the accurate

[1] 'Comme tout ce qui entre dans l'entendement humain y vient par les sens, la première raison de l'homme est une raison sensitive ; c'est elle qui sert à la raison intellectuelle ; nos premiers maîtres de philosophie sont nos pieds, nos mains, nos yeux.'—ROUSSEAU, *Émile.* (EDITOR.)

representations of things. But the ordinary word-studies of our schools, which are truly designed to *assist* these operations, are actually made to *exclude* them. The child glides into the habit of accepting words *for* ideas, and thus evades those mental actions which are only to be performed upon the ideas themselves.

The existing systems of instruction are therefore deficient, by making no adequate provision for cultivating the growth of ideas by the exercise of the observing powers of children. Observation, the capacity of recognising distinctions, and of being mentally alive to the objects and actions around us, is only to be acquired by practice, and therefore requires to become a regular and habitual mental exercise, and to have a fundamental place in education.[1]

The importance of training the young mind to habits of correct observation, to form judgments of things noted, and to describe correctly the results of observation, can hardly be over-estimated. It has been well remarked that, 'without an accurate acquaintance with the visible and tangible properties of things, our conceptions must be erroneous, our inferences fallacious, and our operations unsuccessful. The education of the senses neglected, all after-education partakes of a drowsiness, a haziness, an insufficiency, which it is impossible to cure.' Indeed, if we consider it, we shall find that exhaustive observation is an element of all great success. It is not to artists, naturalists, and men of science only, that it is needful;

[1] 'To point out what qualities of mind, or modes of mental culture, fit a man for being a good observer, is a question which belongs to the theory of education. There are rules of self-culture which render us capable of observing, as there are arts for strengthening the limbs.'—J. S. Mill, *Logic*, i. p. 408. (Editor.)

it is not only that the skilful physician depends on it for the correctness of his diagnosis, and that to the good engineer it is so important, that some years in the workshop are prescribed for him; but we may see that the philosopher also is fundamentally one who *observes* relationships of things which others had overlooked, and that the poet, too, is one who *sees* the fine facts in Nature which all recognise when pointed out, but did not before remark. Nothing requires more to be insisted on than that *vivid and complete impressions are all-essential.* No sound fabric of wisdom can be woven out of a rotten, raw material.'

It needs hardly to be repeated, that observation is the starting-point of knowledge, and the basis of judgment and inductive reasoning. In the chaos of opinions among men, the conflicts are usually on the *data*, which have not been observed with sufficient care. Dispute is endless until the facts are known, and when this happens, dispute is generally ended. Dr. Cullen, long ago, remarked: 'There are more *false facts* in the world than false hypotheses to explain them; there is, in truth, nothing that men seem to admit so lightly as an asserted fact.'

Children should, therefore, be taught to *see for themselves, and to think for themselves* on the basis of what they have seen.[1] In this way only can they learn to weigh the true value

[1] 'Nature speaks only to those who have ears to hear. But, under the quickening influence of the educator's mind, the dead starts up into life, the obscure is flushed with light. These transformations are among the common results of good education. It is then the aim of the instruction I am recommending, to make all Nature minister to the awakening of the child's intellectual life, by bringing his mind into direct contact with the material world. This direct contact, except to a limited extent, does not take place spontaneously, but must be secured by the conscious action

of evidence, and to guard against that carelessness of assumption and that credulous confidence in the loose statements of others, which is one of the gross mental deficiencies we everywhere encounter. This is one of the rights of the understanding too little respected in the school-room. Instead of being called into independent activity, children's minds are rather repressed by authority. In the whole system of word-teaching the statements have to be taken on trust. 'This is the rule,' and 'that the usage,' and the say-so of book and teacher is final. Granted that much, at any rate, in education is to be accepted on authority, it is all the more necessary that there should be, in some departments, such an assiduous cultivation of personal observation and independent judgment as may serve to guard against errors from this source.

It may be said that arithmetic forms an exception to what is here stated respecting the prevalence of authority in schools, as its operations are capable of independent proof. This is true, but the exception is of such a nature that it cannot serve as a *correction*; for it reasons not from observed facts, but from assumed numerical data. Mathematics, says Professor Huxley, 'is that study which knows nothing of observation, nothing of induction, nothing of experiment, nothing of causation.'

The foregoing strictures, I am aware, have a variable applicability to different schools. Many teachers are alive to these evils, and strive in various ways to mitigate them; but

and influence of the teacher; and when it is made, trees will find musical tongues, stones preach eloquent sermons, and the running brooks murmur forth instructive lessons. . . . The teacher who does not quicken, quenches intellectual life, and ought to be held as much liable for his malpractices as the medical practitioner who, by his ignorance and mismanagement, destroys the child at its birth.'—*Paper read at Leeds by the Editor.*

the statement, nevertheless, holds sadly true in its general application. There is a radical deficiency in existing educational methods which cannot be supplied by the mere makeshift ingenuity of instructors, but requires some systematic and effectual measure of relief.

VI.—WHAT IS NOW MOST NEEDED.

To supply this unquestionable deficiency, we should demand the introduction into primary education, in addition to reading, writing, and arithmetic, of A FOURTH FUNDAMENTAL BRANCH OF STUDY, WHICH SHALL AFFORD A SYSTEMATIC TRAINING OF THE OBSERVING POWERS. We are entitled to require that, when the child enters school, it shall not take leave of the universe of fact and law, but that its mind shall be kept in intimate relation with Nature in some one of her great divisions, and that the knowledge acquired shall be actual and thorough, and suited to call out those operations which are essential to higher mental growth. It is agreed by many of the ablest thinkers that such an element of mental training is now the urgent want of general education. Dr. Whewell thus defines the present need:—

'One obvious mode of effecting this discipline of the mind is the exact and solid study of some portion of inductive knowledge. . . . botany, comparative anatomy, geology, chemistry, for instance. But I say, the *exact* and *solid* knowledge; not a mere verbal knowledge, but a knowledge which is real in its character, though it may be elementary and limited in its extent. The knowledge of which I speak must be a knowledge of things, and not merely of names of things; an acquaintance with the operations and productions

of Nature as they appear to the eye; not merely an acquaintance with what has been said about them; a knowledge of the laws of Nature, seen in special experiments and observations before they are conceived in general terms; a knowledge of the types of natural forms, gathered from individual cases already familiar. By such study of one or more departments of inductive knowledge, the mind may escape from the thraldom and illusion which reigns in the world of mere words.' [1]

The increasing influence of science over the course of the world's affairs is undeniable. Not only has it already become a controlling force in civilisation, but it is steadily invading the higher spheres of thought, and, by its constant revisions and extensions of knowledge, it is rapidly reshaping the opinion of the world. That such an agency is destined to exert a powerful influence upon the culture of the human mind, is inevitable. Already, indeed, it has become a recognised element of general instruction, but it has been pursued in such a fragmentary and incoherent way, that its legitimate mental influence is far from having been realised. The immediate problem, then, is how to organise the scientific element of study so as to gain its benefits, as a mental discipline. Each of the prominent sciences—physics, chemistry, geology, botany—has its special advantages, and is entitled to a place in a liberal course of study. But some one must be selected which is best fitted to be generally introduced into primary schools. The work must begin here, if it is to be thoroughly done.

The system of teaching by object-lessons is an attempt to

[1] *Lectures on Education, delivered at the Royal Institution of Great Britain.* Dr. Whewell, *On Intellectual Education*, p. 29.—EDITOR.

meet the present requirement in the sphere of primary education. But these efforts have been rather well-intentioned gropings after a desirable result than satisfactory realisations of it. The method is theoretically correct, and some benefit cannot fail to have resulted; but the practice has proved incoherent, desultory, and totally insufficient as a *training* of the observing powers.[1] Nor can this be otherwise so long as all sorts of objects are made to serve as 'lessons,' while the exercises consist merely in learning a few obvious and unrelated characters. Although, in infancy, objects are presented at random, yet, if mental growth is to be definitely directed, they must be presented in relation. A lesson one day on a bone, the next on a piece of lead, and the next on a flower, may be excellent for imparting 'information,' but the lack of

[1] The comparative uselessness of the ordinary object-lessons has been pointed at by Von Raumer (*Geschichte der Pädagogik*), the late Mr. Moseley (in his Reports to the Educational Department), Herbert Spencer (*Essays on Education*), and the editor (*On the Curriculum of Modern Education*). These lessons, though professedly on things, generally tend to become simply lessons on words. The teacher often merely shows the object to the pupils, and tells them its properties, without requiring them to handle, taste, smell, disintegrate it, and analyse it for themselves. Hence what they know of it is chiefly gained by the teacher's explanations, which are intruded between their minds and the object. Then again, the technical words which he gives them as the names of properties which they have not themselves ascertained, tend to become the substitutes for knowledge—words, and little else. But the more important objection to such lessons is, that though they develope mental power, they do not train it. In this respect they accurately represent the practice of Pestalozzi, to whom the conception of them is originally due. Pestalozzi was powerful as a developer, powerless as a trainer, of mind. To use Herbert Spencer's words, 'He lacked the ability to co-ordinate and develope the truths which he from time to time laid hold of.' Hence he never repeated his lessons, never examined his pupils, never took stock of the results gained, nor compared them with the prognostics of his theories.—EDITOR.

relation among these objects unfits them to be employed for developing connected and dependent thought. This teaching can be thoroughly successful only where the 'objects' studied are connected together in a large, complex whole, as a part of the order of Nature. The elementary details must be such as children can readily apprehend, while the characters and relations are so varied and numerous as to permit an extended course of acquisition issuing in a large body of scientific principles. Only in a field so broad and inexhaustible as to give play to the mental activities in their continuous expansion can object-studies have that real disciplinary influence which is now so desirable an element of popular education.

What we most urgently need is an objective course of study which shall train the observing powers *as mathematics train the power of calculation.* From the time the child begins to count, until the man has mastered the calculus, there is provided an unbroken series of exercises of ever-increasing complexity, suited to unfold the mathematical faculty. We want a parallel course of objective exercises, not to be despatched in a term or a year, but running through the whole period of education, which shall give the observing and inductive faculties a corresponding continuous and systematic unfolding. What subject is best fitted for this purpose?

VII.—ADVANTAGES OFFERED BY BOTANY.

The largest number of advantages for the purpose we have in view will be found combined in that branch of natural history which treats of the vegetable kingdom. While each of the sciences has its special claim as a subject of study, it is thought that none of them can compare with Botany in ful-

filling the various conditions now indicated, and which entitle it to take a regular and fundamental place in our scheme of common-school instruction. Its prominent claims are :—

I. The materials furnished by the vegetable kingdom for direct observation and practical study are abundant, and easily accessible, overhead, underfoot, and all around—grass, weeds, flowers, trees—open and common to everybody. There is no expense, as in experimental science. And, in meeting this fundamental condition of a universal objective study, it may be claimed that Botany is without a rival.

II. The collection of specimens may be carried on as regularly as any other school-exercise, while they are just as suitable objects upon the scholar's desk as the books themselves. They cannot interfere with the order and propriety of the class-room.

III. The elementary facts of Botany are so simple, that their study can be commenced in early childhood, and so numerous as to sustain a prolonged course of observation. The characters of plants which engage attention at this period of acquisition are external, requiring neither magnifying-glass nor dissecting-knife to find them.

IV. From these rudimentary facts the pupil may proceed gradually to the more complex, from the concrete to the abstract—from observations to the truths that rest upon observation, in a natural order of ascent, as required by the laws of mental growth. If properly commenced, the study may be stopped at any stage, and the advantages gained are substantial and valuable, while, at the same time, it is capable of tasking the highest intelligence through a lifetime of study.

V. The means are thus furnished for organising object-teaching into a systematic method, so that it may be pursued

definitely and constantly through a course of successively higher and more comprehensive exercises.

VI. Botany is unrivalled in the scope it offers to the cultivation of the descriptive powers, as its vocabulary is more copious, precise, and well-settled than that of any other of the natural sciences. Upon this point—most important in its educational aspect—Professor Arthur Henfrey has well remarked:—

'The technical language of Botany, as elaborated by Linnæus and his school, has long been the admiration of logical and philosophical writers, and has been carried to great perfection. Every word has its definition, and can convey one notion to those who have once mastered the language. The technicalities, therefore, of botanical language, which are vulgarly regarded as imperfections, and as repulsive to the enquirer, are, in reality, the very marks of its completeness, and, far from offering a reason for withholding the science from ordinary education, constitute its great recommendation as a method of training in accuracy of expression and habits of describing definitely and unequivocally the observations made by the senses. The acquisition of the terms applied to the different parts of plants exercises the memory, while the mastery of the use of the adjectives of terminology cultivates, in a most beneficial manner, a habit of accuracy and perspicuity in the use of language.'

Botanical language is the most perfect that is applied to the description of external nature, but its accuracy is not the accuracy of geometry, the terms of which call up the same sharply-defined invariable conceptions. The characters of natural objects are not such rigid and exact repetitions of each other. Nature is constantly varying her types. The

application of botanical terms is, therefore, not a mere mechanical act of the mind, but involves the exercise of *judgment.*

VII. It is congenial with the pleasurable activity of childhood, and makes that activity subservient to mental ends. It enforces rambles and excursions in quest of specimens, and thus tends to relieve the sedentary confinement of the schoolroom, and to promote health by moderate open-air exercise.

VIII. The knowledge it imparts has a practical value in various important directions. It is indispensable to the intelligent pursuit of agriculture and horticulture—avocations in which more people are occupied and interested than in all others put together.

IX. The study of plant-forms opens to us a world of grace, harmony, and beauty, that is not without influence upon the æsthetic feelings, and the appreciation of art. Intimately involved as is the vegetable kingdom with the ever-changing aspects of Nature, it is well fitted to attract the mind to the fine features of scenery, and the grand effects of the natural world.

X. Knowledge of this subject is a source of pure and unfailing personal enjoyment. Its objects constantly invite attention, and vary more or less with each locality, so that the botanical student is always at home, and is always solicited by something fresh and attractive.

XI. The pursuit of Botany to its finer facts and subtler revelations involves the mastery of the microscope—one of the most delicate and powerful of all instruments of observation. It also opens the field of experiment, and affords opportunity for cultivating manipulatory processes.

XII. Notwithstanding the superficial prejudice against Botany, as a kind of light, fancy subject, dealing with flowers

—an 'accomplishment' of girls—it is nevertheless a solid and noble branch of knowledge. It has intimate connections with all the other sciences—physics, chemistry, geology, meteorology, and physical geography—helps them all, and is helped by all. It treats of the phenomena of organisation, and is the proper introduction to the great subject of Biology—the science of the general laws of life.

These considerations show that, for the purpose we have in view—the introduction of a subject into education which shall extend through all its grades, and afford a methodical discipline in the study of things—Botany has eminent if not unrivalled claims to the attention of educators.

VIII.—DEFECTS OF COMMON BOTANICAL STUDY.

But the benefits here sought are not to be gained by the usual way of dealing with the subject. For this end it must be pursued by the direct study of its objects, and in a definite order.[1] The concrete and elementary characters of plants

[1] There may, however, be a question respecting the order of treatment. Some method of studying the subject is of course necessary; but it does not follow as a matter of course that the method of Miss Youmans's book is theoretically the best. She begins, for instance, with leaves, and the first exercise of the observing powers of the child consists in his distinguishing their forms, and receiving from the teacher the conventional names of these forms. That is, she commences with leaves as elements, or units, and gradually advances from the simple to the more complex, imitating in this respect the teacher of reading, who begins with the letters and advances to the words. Strictly speaking, however, this is not Nature's method. Nature has no primer, no A B C for her pupil. She begins with wholes, aggregates, compounds, or so to speak, with sentences, which are, by the analysing mind, resolved into words, syllables, and letters. Without, then, interfering with the main principle, we would suggest that the first lesson should consist (as in Oliver's *Lessons in*

must be made familiar before the truths based upon them can become real mental possessions. The common method of acquiring Botany *in its results*, that is, by going at once to its general principles, is hence peculiarly futile for purposes of education. The mere reading up of vegetable physiology is no better than getting any other second-hand information.[1] To

Elementary Botany) of the examination of an entire plant, with its root, stem, foliage, and flower leaves. This organic whole should be the first sentence for the pupil's reading, and this he should analyse, in a general way, into words, its parts being considered metaphorically as its parts of speech. And this sentence, as forming the *point de départ*—the point to which all his subsequent knowledge is to be referred—he should know thoroughly, both as a whole and in its several parts. He should, moreover, compare it with other wholes before he proceeds to the minuter investigation of its several parts. We believe ourselves that this assumed necessity of commencing with elements, or the minutest portions, in teaching a subject, is an educational fallacy, which involves the important question, whether the teaching is to be analytic, that which the pupil gives himself, or synthetic, that which is imposed on him by the teacher. The mind teaching itself has no choice. It must adopt the analytic method. The mind taught by 'the most stupid and didactic method,' to use Mr. Wilson, of Rugby's, pithy expression, must receive what it can get from the synthetic method. Miss Youmans's method, however, even with the qualifications which we have suggested, has no feature in common with the latter. She fully recognises what we consider to be the teacher's proper function—*the essential contact between the objective fact and the pupil's subjective consciousness.* —EDITOR.

[1] We venture to think that the author, in thus stating the point at issue, somewhat begs the question. It would be utterly inconsistent, certainly, with her and our principles to substitute the 'mere reading up of vegetable physiology' for the investigation of facts at first hand by the pupil; but, inasmuch as many of the functional phenomena of plant-life may be easily learned and appreciated even by very young children, and are, moreover, so closely associated with the facts of Descriptive Botany, there seems no adequate reason for relegating them entirely, as Miss Youmans does, to a subsequent stage of instruction. To most children, the fact that plants are living beings, requiring food, light, and air for their sustenance, and that these are obtained by the various functions of the root, leaves, &c., is far

learn a number of hard botanical terms without really knowing what they represent, or to con over classifications that are equally void of significance, is much the same as any other verbal cramming. The objection to ordinary botanical study is, not that the books do not tell the pupil a great many interesting and useful things about plants, but that he studies it as he does ancient history, treating its objects as if they had all gone to dust thousands of years ago.

Besides, that which goes under the *name* in many of our schools is not *Botany* in any true sense; it is only a *branch* of it. In the early part of the century, the subject had become so overgrown with the mere pedantries of naming, that there came a reaction against systematic Botany, or the study of the relationships of plants, and some went so far as to insist that the whole science could be 'evolved' by studying a single plant. Under the influence of this tendency, Botany became merged in the study of vegetable physiology to the neglect of its descriptive and relational elements. But it is now recognised that all parts of the science are intimately correlated, and that the inner relations of plants can only be well understood by first getting a knowledge of their outer relations. Nevertheless, the tendency to sink it in mere physiology was strongly felt in education, which instinctively seized upon a view of the subject most easily got through books. But vegetable physiology is not Botany any more than the rule of three is arithmetic; and to engage with the body of generalised truths,

more quickening and thought-stirring than any amount of information respecting their forms and the correlation of their parts. And we believe that this knowledge of elementary vegetable physiology might be gained, under suitable direction, without relinquishing the principle that all the pupil's acquisitions are to be the result of his own observation and experiments.—EDITOR.

which makes up the higher parts of the science, before first mastering Descriptive Botany, is like attacking the higher problems of arithmetic before learning its simple rules.

Nor is the case much helped by that casual inspection of specimens in which students sometimes indulge. To pick a flower to pieces now and then, or to identify a few plants by the aid of glossaries and analytical tables, and to press and label them, are, no doubt, useful operations, but they are far from answering the educational purposes here contemplated.

IX.—AIMS OF THE PRESENT WORK.[1]

In the preparation of the present work, the end kept strictly in view has been to make it conform to the laws of mental growth. Although it attempts to make a beginning only, yet it claims to begin right—to teach Botany as it should be taught, and, in so doing, to cultivate systematically those parts of the mind which general education most neglects. It is adapted to these purposes in the following respects:—

In the first place it conforms to the method of Nature by *making actual phenomena the objects of thought.* It continues the direct intercourse of the mind with things, by selecting that portion of the natural world which seems best adapted for the purpose, and providing for its direct and regular study. It is a merit of the plan that it permits no evasion of this purpose, but *compels* attention to the objects selected. There are no lessons to 'commit and recite;' the

[1] It must be remembered that the treatise now republished separately forms the introduction to Miss Youmans's *First Book of Botany.*—EDITOR.

child's proper work being to observe, distinguish, compare, and describe; and thus, from the outset, it is exercising its own faculties in the organisation of real knowledge.

In the second place, the present plan implies that habits of regular observation shall be commenced *early*. This is on various accounts a most important feature. The child should begin to be taught *how* to notice, and *what* to look for, because it is already spontaneously engaged in the work, and needs guidance. While its mental life is (so to speak) external, and it hungers for changing impressions and new sensations, is certainly the time to foster and direct this activity. It is necessary to furnish abundant and varied materials for simple observation in this impressible sensational stage of mental growth, when, as yet, only rudimentary details can be appreciated. At this time they can be rapidly acquired and easily remembered, while, as the mind advances to the reflective stage, unless the habit of observation has been formed, attention to details becomes tedious and irksome.

It is sometimes said that it is absurd to attempt teaching children 'science' before twelve or fourteen years of age; and, if it be meant the memorising of the principles and results of science, the remark is true. But it is not true if applied to the early observation of those simple facts which lead up to scientific principles. Nature settles all that by putting children to the study of the properties of natural objects as soon as they are born. The germ of science is involved in its earliest discriminations. When the child first distinguishes its father from its mother, it is doing the same thing that Leverrier did in distinguishing Neptune from a fixed star; the difference is only one of *degree*. In putting children early to the work of observation, as is provided for in this little work,

we are, therefore, only continuing a course already entered upon, and which involves the most natural and congenial action of the childish mind.

Another reason why children should commence the study of objects early is, that the *habit* may be formed before the mind acquires a bent in other directions; is, because to postpone it is to defeat it. As education is supposed to begin when school begins, and to consist mainly in learning lessons, children quickly get the notion that nothing is properly 'education' that does not come from books. But the difficulty here is deeper still. The habit of lesson-learning, of passively loading the memory with verbal acquisitions, is so totally different a form of mental action from observing, enquiring, finding things out, and judging independently about them, that the former method tends powerfully to hinder and exclude the latter. I have found, in my own experience, that the younger children took to exercises in observation with freedom and zest, while their elders, in proportion to their school proficiency, had to overcome something of both disinclination and disqualification for the work.

In the third place, the plan of study here proposed recognises the importance in education of the element of *time*. The very conception of mental unfolding as a *growth* implies, as we have seen, an orderly succession of natural processes to which *time* is an indispensable condition. Ideas are not only to be obtained by observation, but they are to be organised into knowledge. That this may be done effectually, so that acquisitions shall be lasting, it must be done slowly and by numberless repetitions. The plan of this First Book complies with this condition by such a construction of the exercises as will

secure constant repetition and a thorough assimilation of observations.

It complies with the time-requirement in another respect also: it is but a *first* step, and involves many succeeding steps. The mind grows, let it be remembered, for twenty or thirty years, passing through successive phases, in which now one form of mental action predominates, and now another. Every study, which aims to cultivate any class of mental activities up to the point of *discipline*, must extend through a considerable part of this period. This is well understood with respect to mathematics and Latin; they run through from the ages of seven or eight years to college graduation; while *three months* is the usual collegiate allowance of time for Botany. As the true mode of treating the subject, both on its own account and for educational purposes, requires that it be pursued in a definite order through the whole school career, I have here conformed to that condition by presenting only the first rudimentary instalment of the subject.

Fourthly and finally, the mode of study here proposed is specially suited to call forth those operations in which growing intelligence consists.

A child old enough to begin the study of Botany has already acquired a large stock of ideas of concrete things and their relations. As concerns plants, it has probably discriminated between leaves, flowers, stems, and roots. Its idea of a leaf, for instance, though loose and indefinite, is still roughly correct. The thin, green plate contrasts strongly with the other parts of the plant. Its differences from flowers and stems enable the mind readily to differentiate it in idea, while the essential resemblances of leaves of all kinds make their integration into one general conception inevitable.

Our primary scholar, then, starting at the level of ordinary perception, is to increase his discriminative power. He must learn to discover minuter differences and resemblances, and to make his ideas more definite and precise. To this end he enters upon the first exercises of this work, and begins a careful inspection of leaves. He soon finds that they vary considerably; that their most conspicuous feature—that which he has hitherto regarded as the *entire leaf*—forms, in most cases, but *one part* of the leaf. Having gained a clear idea of this part, he marks his conception of it by a sign which he finds to be the word *blade.* Another part, almost always present, he distinguishes as the leaf-stem, and names it the *petiole*; and still another part, probably never before noticed, he learns to recognise as the *stipules.*

He thus begins with the recognition of simple differences, the idea of the leaf being resolved into three component ideas. But each of these component ideas is crude from lack of observation of the varying forms of different blades, petioles, and stipules. Observation is now extended to new specimens, and as it goes forward new differences are perceived among these parts. The blade turns out to be composed of different elements. Its framework is differentiated from its soft, pulpy covering, receives its name, and then *this part* opens a new field of observation in recognising and comparing the different modes and variations of the *venation*, as it is called.

In this way there grows up an intelligent conception of the leaf. Its idea, at first vague and homogeneous, by successive discriminations of differences and resemblances has become definite and heterogeneous. The conception, at first simple, is now complex, but it is an orderly complexity, in which the parts of the object, with the relations of those parts, are dis-

tinctly possessed in thought. After a month of observation so conducted, in which numerous specimens are observed and compared, and their peculiarities noted and named, the pupil will have begun to acquire some facility in observing and describing, and will have gained a good deal of knowledge of this elementary portion of the subject.

Having gone over simple and compound leaves, he next passes to the examination of the stem. Here, also, his first notion is simple and indefinite, but, when a good many have been noticed, marked differences of appearance present themselves, and stems begin to fall into groups, which he describes as round, square, erect, trailing, creeping, &c., as the case may be; while closer observation reveals still minuter characters of difference and resemblance among them. Inflorescence, flowers, and roots, are successively studied in the same manner.

Beginning thus with the rudimentary characters of the simplest parts, the child proceeds step by step, until he becomes acquainted with the leading characters of the plant as a whole, while the faculties drawn out, and the work of drawing them out, conform to the first conditions of unfolding intelligence. A multitude of accurate botanical ideas have been obtained of the endless diversities of feature and form in the vegetable world, but they do not lie as a burden of details in the memory; they have been arranged into organised knowledge. Particular facts are gradually fused into general conceptions; each new peculiarity observed is a discrimination of difference or likeness which links itself to previous conception. The simplest ideas are at first associated in minor groups, and soon reappear in larger groupings and relations, until at length the whole plant has been reproduced in the

mind as a highly complex organism of thought-relations—the mental representation being as truly a product of growth as the living object itself.

It has been explained that the first and simplest thinking involves the rudimentary act of classing. Botanical study, pursued in the direct way here practised, is specially fitted to cultivate this form of mental exercise, as Botany is eminently a classificatory science. Beginning with the simplest discriminations and comparisons, the pupil has arranged the characters observed into groups in accordance with their resemblances. As he becomes able to grasp in thought these assemblages of characters, and to discern remoter relations of likeness, the classification is carried further, and he is thus gradually prepared to go on and trace out those larger and more complex relationships of difference and resemblance by comparison of *all* the characters of plants, which lead to the complete classification of the vegetable kingdom on the natural system.

This mode of mental acquisition has also enforced a salutary training in the use of language. Words are used with more clearness and reality of meaning, and, instead of rehearsing what others have observed, he learns to describe what he has seen and knows himself. In this way he goes *behind* the words to the ideas, and things they symbolise, and can better appreciate both their value and their imperfection as signs. For example, upon first noting a plant character, he confidently applies a term to it; but, upon looking further, he perhaps fails to find the exact repetition of it, and doubt may arise about its new application. He soon discerns that Nature's plan is not that of sharp lines of distinction, but that she rather *flows* from character to character in ceaseless continuity, and never exactly repeats herself. Words are therefore no

longer to be accepted as the *absolute equivalents* of things; they cannot represent the delicate shadings, and the infinite variety of nature and of thought; they are but imperfect signs, frequently liable to mislead, and therefore demanding judgment in their use.

This exercise of judgment, which is constantly required in estimating characters and in making plant-descriptions, is of incalculable advantage to the young. Although the child's warrant for his statement is, 'I saw it,' yet he quickly learns that the main thing, after all, is, how the thing seen *is to be regarded*. He is constantly called upon to make up his mind; he will have frequently to suspend his opinion, and sometimes, perhaps, to maintain it against his teacher. But this is just the kind of mental work that he will have to do in after-life, in forming his conclusions upon subjects of familiar observation and practical experience.

SUPPLEMENT BY THE EDITOR:

ILLUSTRATING THE FOREGOING PRINCIPLES AND APPLYING THEM TO THE ELEMENTARY STUDY OF MECHANICS.

It will have been seen that the special characteristic of the method of this book is, that the author insists on the principle that all elementary instruction which is intended to train the mind must be based on objective, concrete fact, and provides no other basis. The facts themselves, not the explanations, deductions, or comments of others upon them, are to be brought at first hand into immediate contact with the pupil's mind. In the natural order of things, the facts come first, the comments afterwards, and the child, in his acquisition of knowledge, should follow the natural order. This is the historical method, the method of the investigator, who gains his ends by observation and experiment, acquiring knowledge by the exercise of his senses, by analysis and comparison, and testing it by synthetical applications. The child, too, may be regarded as an explorer or investigator, who is to proceed by the same method. He, too, can gain knowledge by observation and experiment, and that only is truly his own which he gains by these means.

This proposition will be considered by many teachers as needing proof. The remark is, however, intended to apply only to the *most elementary instruction*, as part of a system of *mental training*. The purpose of such instruction should obviously be to impress upon the pupil's mind clear and defi-

nite ideas, however few, and to foreclose his mind, for the time being, to all others.[1] The quantity of knowledge that he gains under the process is of small importance compared with its quality, and its quality depends upon the manner in which he gains it. What he gains at first hand, by his own mental labour, and what he acquires as the result of other people's labour, may both become his own property, but they are different in their nature, and are held on totally different tenures; and it is maintained that the child *under training* is only concerned with the former. He is to learn how to acquire prcperty himself, that he may know the value of property in general, and may be able to appreciate the various methods by which others acquire it. In a similar way, the mechanic learns his art by continually handling his tools, until having gained experience by daily practice, he at length becomes capable of appreciating the finished and elaborate work of his more advanced fellow-labourers. His competency, however, to form a mature judgment on their performance, and to do what they do, is founded essentially on his own previous knowledge and experience. It is in this sense that the assertion is made, that in the case of a child under elementary training, that knowledge only which he gains by his own observation and experiment is truly his own.

The time of course comes when he must receive many things on the authority of others, as, for instance, when he learns Geography and History. These subjects do not indeed, consistently with the views here maintained, enter into the curriculum of the *earliest* elementary instruction, which should

[1] 'L'esprit de mon institution n'est pas d'enseigner à l'enfant beaucoup de choses, mais de ne laisser jamais entrer dans son cerveau que des idées justes et claires.'—Rousseau, *Émile.*

be strictly confined to matters on which the pupil can exercise his own powers of observation and experiment. When, however, the time does come for learning them, it will be found that the child furnished with a substratum of knowledge gained by his own efforts, will be in a far better condition for receiving and appropriating that supplied him by others than one who has not had the previous training.

It may, however, be further objected, that it is unreasonable to require the pupil to discover for himself what has been already discovered by others, and lies ready at hand. The objection would be valid if it were true that he *could*, while yet a novice in learning, in the true sense of the term, appropriate what another has gained; but the fact remains that the child's mental appropriation of objective knowledge can be secured only by certain subjective processes which another can no more perform for him, than walk, sleep, or digest for him. That only, therefore, in an educational sense, is knowledge to us which we have gained through the working of our own minds. We do indeed please ourselves with the fancy that we can assume as our own the vast field of science which we have, as a people, inherited; but after all, it is an ultimate fact of human nature, that there is no 'common measure' between a nation's progress in knowledge and an individual's; so that, however large may be the inheritance bequeathed to us, we can enter on it in no other way than that by which it was first acquired—the way of observation and experiment. Whatever is acquired by any other means is of the nature of cramming, and has nothing in common with the true *elementary culture* of the mind.[1]

[1] The writer is anxious to guard against any misconstruction of his meaning in reference to 'cramming.' He has already denounced its

These considerations help us to define the relation between the material of instruction, the learner, and the teacher. The material should be objective, concrete fact; the learner, one who applies his senses, his powers of perception, apprehension, analysis, comparison—his whole mind, in short—with a view to ascertain the nature and phenomena of the fact, by interrogating it in every possible way; and the teacher, one who, recognising and understanding the learner's process of investigation, aids him in it by every means which does not interfere with it. He does not, therefore, tell his pupils that this object is hard, that soft; he makes them feel it themselves; he does not explain that this object has a certain external relation to that; he places them in juxtaposition, and invites comparison; he directs them to congregate particulars, and at the right time calls for generalisation and classification; he does not point out that this is a cause, and that an effect, but prompts them to make the experiments which suggest the relation; he does not anxiously correct their blunders, but, either at the moment or subsequently, takes care that they are corrected by themselves; he gives them no technical names until they know the things or phenomena which require to be named; and finally,

'unlawfulness' as a part of elementary training, but he admits, of course, its lawfulness and indeed necessity, in a more advanced stage of instruction, and in the business of life. What he insists on is that by enfeebling the growing powers it is antagonistic to mental culture, and, moreover, that when it is necessary, the cultivated mind will appreciate in a higher sense and appropriate far more effectually the knowledge gained by others, than the mind which has been accustomed from the beginning blindly to receive and adopt the conclusions of others as its own. In other words, the mind that is not used to cramming will cram to far better purpose when the occasion arises than that which is; and will, besides, more competently deal with general propositions framed by others from having been employed in forming such propositions itself.

distrusting their memory, he often repeats his lessons in order to deepen impressions and prevent the loss of what has once been acquired.

From this enumeration of the several functions of the learner and teacher, it is clear that the former is an investigator engaged in teaching himself by means of concrete facts, and that the latter is a guide, director, or superintendent of the process by which the pupil learns.

These views of the respective functions of the learner and teacher will of course hardly satisfy those who assume that everyone who knows a subject is competent to teach it: all experience, however, is against this assumption. The teacher should indeed thoroughly know his subject. This knowledge will guide him in bringing the object to be learned in contact with the pupil's consciousness by the questions he asks, and is, moreover, a guarantee that he has himself had experience of the subjective process of learning, but is no guarantee that he has a right conception of his proper function as a teacher, or a conscious knowledge of the process by which all minds learn. He may know his subject, but be entirely ignorant of the best means of making his pupils know it too, which should be the end of all teaching. The question at issue resolves itself, indeed, into that of the means by which knowledge is naturally gained; and the main point in the enquiry is, How is all knowledge which we can truly call our own obtained? Does a child come to know a flower, for instance, because his teacher, having exercised his mind upon it, knows it, or because the child himself has exercised his own mind upon it? Even if we allow—which we do not—that the child is incapable of seeing the flower aright, of discriminating between its parts, and appreciating their relations by his own powers of

mind, it must be admitted that the ultimate act which makes the idea a mental possession is, and must be, the child's own, not the teacher's. But indeed all the processes of perception, observation, comparison, reasoning, judgment, by which solid knowledge is gained, are so many means by which the investigating mind works in attaining its object, and can only be performed by the learner himself. The teacher who intrudes the knowledge he has gained by means equally accessible to the child, does a work of supererogation, and gives at second hand what the learner would better gain at first hand, and by so doing supersedes the more valuable teaching given by the fact or object itself. In learning what an object is, the object itself is the best possible teacher. The lessons it gives are clear, forcible, and definite, and stamp themselves directly on the mind. Those substituted for them by the professed teacher, may be quite otherwise, inasmuch as if he learned them originally from the object itself, he may not have learned them correctly, or if he merely transmits impressions which have passed through other minds without reference to the original teacher—the fact or object—he may convey error instead of truth to his pupil. No account, in short, can be given by another, of the nature of an object equal in vividness, force, and truth, to that which the object itself can give. But further, the teacher who assumes that his best service to his pupils consists in doing their proper work of observation, &c., for them not only does what is unnecessary, but what may be positively injurious. His professed object, as a teacher, is to educate as well as to instruct; to train the faculties through the process of instruction.[1] But he can train only by calling into

[1] It may be worth while to remark, as the point is often misapprehended, that Education (from *educare*, a frequentative of *educere*, to draw forth)

exercise the pupil's own powers. The substitution of his own thought for the pupil's, except as a means to this end, tends to defeat the object in view. All explanations, therefore, by the teacher, of relations which are obvious and patent in the things themselves, supersede the pupil's own mental activities, and hinder, to some extent, that exercise of mind which is essential to development and training. Explanation is 'flattening,' 'making level,' or 'clearing the ground,' so as to produce an even surface, and as applied to teaching, signifies, removing obstructions out of the way. This work, however, as being, in our view, the only means by which the pupil's mind is to be trained to the consciousness of its powers, belongs to the learner not to the teacher, and the teacher who does it for him injuriously interferes with, and in fact defeats, as we have just said, the object in view. The human mind, which is naturally endowed with a capacity for observing aggregates, is also endowed with a capacity for disintegrating them, and detecting the relation of the parts to the whole, and further, with a capacity for reasoning on these relations and forming a judgment upon them. It has, moreover, the ability to apply the knowledge thus gained to the acquisition of more—to use the known to interpret the unknown. All these processes are essentially of the nature of explanations, but then they are explanations which result from the working of the learner's own mind on the matter

is the drawing forth, by *repeated acts*, of the pupil's powers, the training of them to their proper work, and that Instruction (from *instruere*, to place materials together *for a definite end*) is the orderly placing of knowledge in the mind. Hence, only an instructor scientifically equipped for his profession is at the same time an educator. The teacher who merely gets his pupil to accumulate disconnected bits of 'information' about all sorts of subjects is no instructor, and, therefore, no educator, in the true sense of the terms.

of study, not from the working of the teacher's mind; and to return to the former assertion—the teacher who intrudes his own explanations injuriously interferes with the machinery, and hinders it from securing its best products. The teacher's whole business, in short, is to teach his pupil how to think, and this can only be effected by making him do all the thinking himself, 'absolutely without aid' (see Dr. Temple's remark below), not by thinking for him.[1]

It scarcely needs to be pointed out, that the question of the necessity of explanations in elementary teaching involves that of the subjects and order of studies. 'If the subject is unsuited to the child's stage of instruction, or if, instead of presenting

[1] There is abundant authority for the correctness of these views on the value of the learner's self-tuition. 'All the best cultivation of a child's mind,' says Bishop Temple, 'is obtained by the child's own exertion, and the master's success may be measured by the degree in which he can bring his scholars to make such exertions absolutely without aid.' Rousseau, too, recommending self-teaching, says, 'Forcé d'apprendre de lui-même, il (the pupil) use de sa raison et non de celle d'autrui, car, pour ne rien donner à l'opinion, il ne faut rien donner à l'autorité; et la plupart de nos erreurs nous viennent bien moins de nous que des autres. De cet exercice continuel il doit résulter une vigueur d'esprit semblable à celle qu'on donne au corps par le travail et par la fatigue. Un autre avantage est qu'on n'avance qu'à proportion de ses forces. L'esprit, non plus que le corps, ne porte que ce qu'il peut porter. Quand l'entendement s'approprie les choses avant de les déposer dans la mémoire, ce qu'il en tire ensuite est à lui; au lieu qu'en surchargeant la mémoire à son insu on s'expose à n'en jamais rien tirer qui lui soit propre.' Again: 'Sans contredit on prend des notions bien plus claires et bien plus sûres des choses qu'on apprend ainsi de soi-même que de celles qu'on tient des enseignements d'autrui; et, outre qu'on n'accoutume point sa raison à se soumettre servilement à l'autorité, l'on se rend plus ingénieux à trouver des rapports, à lier des idées, à inventer des instruments, que quand, adoptant tout cela tel qu'on nous le donne, nous laissons affaisser notre esprit dans la nonchalance, comme le corps d'un homme qui, toujours habillé, chaussé, servi par ses gens et traîné par ses chevaux, perd à la fin la force et l'usage de ses membres.'—*Émile.*

him with facts which he can understand, we force upon him abstractions which he cannot, we create the need for explanations.' He can understand concrete facts, by applying his natural faculties of observation to them, but he cannot understand general principles framed by others upon facts which he does not know. The recognition of this principle furnishes a test of the suitability of any given subject for the earliest stage of elementary instruction. Those subjects alone are suitable which admit of independent investigation, which require no evidence but that of the senses, and can therefore be brought into immediate contact, without the descriptions and explanations of others, with the learner's own mind. In the progress of instruction, the knowledge gained by others—as in Geography and History—will fitly take its proper place; but in the first instance and with an especial view to training the mind, the pupil's knowledge should be all his own—the sole product of his own thought. Facts, then, and phenomena—the facts and phenomena of the material world—are the proper food of the mind learning to think, and it is the perception and appreciation of this principle which constitutes the merit of Miss Youmans's method of teaching Botany.

It is important, however, to remark, that, valuable as the study of Botany is as a means of cultivating the observing powers, it fails to secure all the elementary training of which children are capable. It leaves altogether uncultivated the instinct of experiment, which, equally with observation, is an indispensable agent in the acquisition of physical knowledge. A child may become a proficient in Descriptive Botany and remain ignorant of the action and reaction of forces, and of the relation between cause and effect. Yet this knowledge

as a means of quickening mental effort is of even more value than any that can be obtained from observation alone, and tends more directly to form the scientific mind. Children are always delighted with experiments, especially with those which they make themselves. They like to set objects in motion, and to watch the results.

The elementary discipline, then, which is to be a continuation of Nature's method should provide a systematic training in the doctrine of forces.[1] This training will be one day recognised as the true basis of that Technical Education which is the desideratum of our times.

We are not yet furnished with a systematic arrangement of means and agencies for such training, but in the meanwhile a typical and theoretical specimen is here given of the manner in which instructions of this kind might be conducted; which will also serve as an illustration of the principles already insisted on.

It may be premised that the object of this specimen of a lesson is to show:—

(1.) That the pupils throughout the lesson are learning, i.e. teaching themselves by the exercise of their own minds, without, not by, the explanations of the teacher.

[1] That such knowledge is within the comprehension of children is shown with admirable tact and skill in Miss Edgeworth's *Harry and Lucy*, as well as by the numerous actual experiments in education recorded in Mr. Edgeworth and his daughter's joint work on *Practical Education*. It is much to be regretted that these valuable works, superseded by none in recent times, are apparently falling into oblivion. When the nature and requirements of elementary training are better understood, and our traditional routine submitted to the test of educational science, teachers will study with deep interest the numerous experiments in education which are minutely described in them, and recognise the sterling merits of the Edgeworthian method.

(2.) That the pupils gain their knowledge from the object itself, not from a description of the object furnished by another.

(3.) That the observation and experiment by which their knowledge is gained, are their own observation and experiment—made by their own senses and by their own hands; as investigators seeking to ascertain for themselves what the object before them is, and what it is capable of doing.

(4.) That the teacher recognises his proper function as that of a guide and director of the pupil's process of self-teaching, which he aids by moral means but does not supersede by the intervention of his own knowledge or explanations.

Suppose, then, a large working model of the pile-driving machine placed in view of the whole class. As it is well known, it is not necessary to describe it. The resistance of the earth may be represented by a socket made of boards connected by strong springs.

I. The teacher simply remarks that the object before them is called a 'machine,' and that its purpose is to drive the pile into the socket which represents the earth. He also tells them the names (merely as conventionalities which they cannot find out for themselves) of the 'monkey,' the 'clutch,' the 'pulleys,' &c. The children are eager to see what the machine can do. He therefore directs two of them to lay hold of the cords and pull up the weight or 'monkey.' This they do gradually until the clutch relaxes its hold, and the weight falls down on the head of the pile. The weight is then replaced in its original position, and all the children in succession make the experiment. This employment of their own powers involves a personal experience of resistance to muscular effort, and a rudimentary idea of force.

The teacher next directs them to measure the height from which the weight falls, as well as the height of the head of the pile from its insertion in the socket. He also detaches the monkey from the clutch, directs them to weigh [1] it, and he records the results on the black board.

He then replaces the weight in its original position, and directs the children to repeat the experiment; but this time the height of the pile is measured after the fall of the monkey, and the difference recorded on the black board. 'The iron weight of — lbs. drives the pile into the earth — inches.'

He next substitutes for the iron weight masses of equal volume made of lead and wood, directing the children in each case to weigh the several masses and recording for them the several results of the impact.

Teacher. Which weight drives the pile most, which least?

Answer. The leaden one most, the wooden one least.

T. Why?

A. Because the leaden one is the heavier and the wooden one the lighter.

T. How many inches in each case?

A. The leaden one — inches, the wooden one — inches.

T. What are the weights of each?

[1] Arrangements for accurately weighing and measuring should always form a part of the school apparatus, and should be used not for, but by the pupils. They should also be practised in poising weights in their hands, and in conjecturing heights and distances by the eye, and then comparing the mental surmise with the facts, as ascertained and confirmed by actual experiments. Much valuable mental discipline, as well as preparation for the business of life, is involved in processes of this kind. The vague evidence often given in courts of law on such points, shows how much they are neglected in early training.

A. The leaden one weighs — lbs., the wooden one — lbs.

T. How do you state the result?

A. The leaden weight drives the pile twice as deep as the wooden one.

T. Measure exactly the leaden and the wooden weights; the length, height, and thickness of each. What is the result?

A. They are exactly the same size.

T. We will say that they are of equal *volume;* yet being of equal size or volume, and falling from the same height, you say that the leaden weight produces twice as great a result as the wooden one.

A. Yes, because it is twice as heavy. We found that it weighed twice as much.

T. That is, as you told me, the leaden monkey weighed, say 20 lbs., and the wooden one 10 lbs., both having the same volume.[1] How do you account for this?

A. We don't know how it is.

T. Well, here is some wool. Weigh out two parcels of it which shall be exactly equal to each other. Take one parcel and squeeze it gently into a ball, squeeze the other parcel also into a ball tightly, so that the one ball shall have as nearly as possible double the volume of the other. What do you notice?

A. That the quantity of wool is in both cases the same, but that in the one case it is packed twice as closely as in the other, so that it occupies only half the space.

T. We will call the wool, as being something that we can see,

[1] The teacher may legitimately aid his pupils by summing up and keeping before them the results they gain; that is, in the intellectual chase in which they are engaged, he may, if he thinks fit, carry the game-bag for them. This will often be found a great support to the attention.

touch, and smell, *matter*, and the 'close packing' *density*. How do you apply these terms?

A. The quantity of matter in the two balls is equal, but the density of one is twice as great as that of the other.

T. Now returning to the case of the leaden and wooden weights, how do you account for the fact that though equal in volume, the one weighs twice as much as the other?

A. In the leaden weight, the matter is twice as closely packed, or twice as dense as in the wooden one.

T. Now again. What was the effect of your squeezing the parcels of wool?

A. To bring the bits of wool closely together.

T. Call these 'bits' *particles*. Why is it possible to bring them closer together?

A. Because there are spaces between the particles.

T. These spaces are called *pores*, and the fact that there are such pores, is called *porosity*. What relation has this quality to that of density?

A. It is the opposite to *density*. The more dense anything is, the fewer pores it has; the more pores it has, the less dense it is.

T. How can you express this generally?

A. The greater the porosity, the less the density; the greater the density, the less the porosity.

T. Terms like density and porosity thus related to each other, are called *correlative*, and we may therefore speak of the *correlation* of density and porosity.

II. The teacher now shifts the beam; arrangements having been previously made for raising or lowering it. The experiments are repeated. The beam is gradually lowered, and the

results recorded as before, until there is no height to fall from; the weight simply resting on the head of the pile.

T. What did you observe as the height was gradually lessened?

A. That the pile was less and less driven down.

T. Why was this?

A. Because the monkey did not fall so far.

T. But if the weight is the same, why do the results differ?

A. It is the falling of the weight that makes the difference.

T. This 'falling' is called *motion*—what is it, then, which produces the result?

A. The motion of the weight.

T. Let us call the weight as producing an effect in driving the pile, a *force.* What is it when actually driving the pile?

A. A moving force.

T. A moving force is called *momentum.* What is it made up of?

A. Motion and weight.

T. In what way could you drive the pile down without the motion of the weight?

A. By making the weight a good deal heavier.

T. What advantage, then, is gained by making the smaller weight do the work?

A. It is much more convenient; the smaller weight does as much work by its motion as a larger one would do without motion.

The teacher now detaches the monkey and substitutes one half the weight; he directs the pupils to experiment with this as they did with the first, and to measure the result;

then to attach the original weight so that it may fall from half the original height, and to compare the results.

T. What is the momentum in these two cases?

A. The same.

T. State the result.

A. The weight of — lbs. falling from a height of — feet produces the same effect as the weight of — lbs. falling from half the height. The greater fall makes up for the smaller weight.

T. Mention other instances of momentum.

A. A battering ram, a cannon-ball, a marble shot at another, a stone breaking a pane of glass, a hammer driving a nail, &c.

T. You spoke just now of the falling weight as a 'moving force.' May the weight acting by itself without motion also be a force?

A. Yes; if it were placed upon an apple, it would crush the apple.

T. What other kinds of force can you mention?

A. The wind is a force when it blows down a tree; water is a force when it moves the water-wheel of a mill; gunpowder is a force when it explodes and bursts a rock to pieces, or when it drives a cannon-ball through the air; our strength is a force when we pull up the monkey, &c.

III. The teacher now directs the pulleys to be removed and the weight to be pulled up without them. The children are at once sensible of the increased difficulty.

T. What difference do you now perceive in your pulling?

A. We are obliged to pull harder than we did before.

T. Why is that?

A. Because the rope rubs on the edge of the board, which

does not give way; when it moved on the pulleys, the pulleys gave way.

T. This rubbing is called *friction.* Could you lessen it without using the pulleys?

A. Yes, by putting some grease on the edge of the board.

T. Try that.

The experiment is made accordingly, and the rope of course moves more easily; the pulleys are then replaced.

T. What, then, is the use of the pulleys here?

A. By giving way they lessen the amount of friction.

IV. The teacher restores the apparatus to its first condition, and directs the children to notice especially the fall of the weight.

T. Why does the weight fall?

A. Because the clutch opens and lets it go.

T. But why does it *fall*?

A. Because every heavy body falls down of its own accord to the earth.

T. Give other instances of falling bodies.

A. If we throw a stone up into the air it falls down, if we let go when we are climbing up a tree we fall down, &c. The earth seems to pull everything down to itself.

T. This pulling force is called *gravitation*, or *the attraction of gravitation.* What makes the weight fall when it is left free?

A. The attraction of gravitation.

T. Describe it in this case.

A. The earth attracts the weight, and the weight falls by the attraction of gravitation.

T. Look carefully at it as it falls. Does the attraction increase or lessen?

A. It seems to increase. The weight falls faster and faster.

T. Swiftness of motion is called *velocity*. How do you apply the term here?

A. The velocity increases as the weight gets nearer and nearer to the earth.

T. A velocity which increases is said to be *accelerated*. How do you apply the term to the case before us?

A. The attraction of gravitation causes a body left free to fall, to fall towards the earth with accelerated velocity.

T. But how much is the velocity accelerated?

A. We cannot tell, the weight moves so very fast.[1]

V. *T.* A thing that makes a change in another thing is called a *cause*, and the change itself is called an *effect*. What instances of cause and effect do you perceive in the action of this machine?

A. The pulling of the rope causes the weight to rise, the letting go of the weight causes it to be left free, the attraction of gravitation causes it to fall, and the momentum of the weight causes the pile to go down.

T. What was the first cause which led to all the others?

A. The strength of our arms.

T. Tell me the causes separately.

A. 1. The strength of our arms. 2. The setting the weight

[1] The teacher may, if he sees fit, put many more questions on the phenomena of falling bodies, and even introduce Attwood's machine to the notice and investigation of his pupils, who will be found quite capable of comprehending its action. In reply to an objection that has been made to the use of costly machines in common schools, the writer would suggest that they might be let out on hire, and passed on from school to school as required. The expense in this way would be trifling, while the benefit would be very great.

free. 3. The attraction of gravitation which gave the weight its momentum.

T. Now tell me the effects separately.

A. 1. The lifting of the weight. 2. The setting the weight free. 3. The blow upon the head of the pile.

VI. *T.* Now I will read to you from a book some descriptions, which are called *definitions*, of a few of the special words called *technical terms*, which we have been using.

1. 'A machine is a contrivance for applying or regulating a moving power or force.' Explain this by what you know.

A. The moving force is the weight falling down; it is applied to the head of the pile; and it is regulated by making the weight heavy enough to do the work well, and by letting it fall exactly on the top.

T. Here is another definition.

2. 'The force exerted by a mass of matter in motion is called, in mechanics, momentum or moving force.' Explain this.

A. The mass of matter in motion is the weight, and it exerts its force in driving the pile.

T. Here is a third definition.

3. 'Friction or rubbing is the resistance which a moving body meets with from the surface on which it moves.' Explain this.

A. The friction of the rope against the board when the pulleys were taken away prevented us from pulling up the weight easily.

The teacher may give at will more or fewer of these definitions, but will require in each case that the explanation of the pupil shall be founded on the facts that he knows. This

condition is indispensable. A definition founded on facts which he does not yet know, is no definition to him. This consideration suggests the expediency of endeavouring to obtain from him in his own language, however imperfect, the expression of the ideas, which he has gained from the facts with which he has been dealing, *before* the definitions of others, founded on the same or similar facts, are brought under his notice. The teacher closes the lesson by directing every pupil to write down the definitions, as he may remember them, each on a separate page of a book set apart for the purpose, with a view to placing under them the new cases which may afterwards occur, as additional illustrations. He adds, in dismissing the class: 'Let each one contrive some other machine for doing the same work, and bring a model or drawing of it for the next lesson.'

The next lesson will consist of a repetition of the main points of the first, with an examination into the action of the clutch, more experiments on velocity, momentum, friction, &c., as shown in other machines and in common operations known to the children. The products of their own invention will then be brought forward and submitted to the criticism of the class, guided by the teacher, who, in his turn, may give his own inventions, and submit them to criticism. The definitions, too, will be repeated and tested by the facts. In the third lesson the teacher, *having removed the machine out of sight*, will examine the class upon the *ideas* they retain of its form, operations, &c., as well as on the technical terms which they have learnt, and finally exhibit a well-executed drawing of the machine, which is forthwith to take its place on the walls of the school-room.

The first sentence in the language of machines has now been

to some extent learnt—learnt as a whole and in its principal parts; its clauses, many of its words, and of some of its letters appreciated. It is the *point de départ* from which the pupil sets out in the acquisition of fresh knowledge of the general subject, and to which all that knowledge is to be continually referred. It is the 'quelque chose' of Jacotot's famous maxim, 'Apprenez quelque chose et rapportez-y tout le reste.'

In reflecting on the principles involved in this lesson, we notice,

1. That the learner has throughout had his mind brought into direct contact with material substances and phenomena at first hand; these he has himself seen, handled, and experimented upon, and in so doing has gained mental cognitions and experiences more valuable than any that he could have gained by descriptions of them or commentaries upon them furnished by others.

2. That the method he has employed is the true method of analytical investigation, and proceeds from the whole to the parts, from the complex to the simple, and not *vice versâ*.

3. That by being an observer, explorer, and experimenter on his own account, examining things with his own senses, and employing his own intellect directly upon them, the ideas that he gains respecting them are clear and definite as far as they go, and serve as a solid substratum for those which he is afterwards to associate with them.

4. That he learns to use words as the symbols of things that he knows, technical and conventional terms being supplied, when, and not before, they are needed to facilitate the operations of the mind.

5. That the habits of mind acquired by the process of teaching himself in this special case, are such as prepare

him for independent mental self-direction, and therefore for the successful study of other subjects, literary as well as scientific.

We also notice (6) that the teacher while really the main-spring of the educational machinery—all along supporting its movements by his moral and intellectual influence—acts strictly as the superintendent of the processes on which its efficiency depends. He removes, when necessary, hindrances out of the way, and places the workers in the best position for accomplishing their object, but he carefully abstains from doing any part of the work for them. He directs their action but does not interfere with it. He therefore explains nothing, and tells nothing, except technical terms, which, as being conventional, the children could not find out for themselves. He uses no book, but treats the machine as a book, which they are to learn to read for themselves under his direction.

Opinions will of course differ as to the value of this typical first lesson in mechanics. It may be said that the information gained by it is very small, and might more easily have been given by the teacher. A full reply to this objection would be a mere repetition of the principles already stated. It must, however, be remembered, that mental training—the direct object in view—does not consist in giving information, but rather in stimulating the mind to gain information for itself. The act of gaining it by a mental effort involves and *is* the training of the faculties. In the lesson just described, whatever knowledge was gained was the direct result of the pupil's own observation and experiment, through the teaching of the machine—not through the didactic teaching of the instructor. The pupil was an original investigator, applying all his powers to ascertain

what the machine was and what it could do, and the teacher was a superintendent or director of the process, anxious to make it as fruitful and efficient as possible. As the head-teacher—the machine itself—was at hand, ready to interpret itself in the expressive and forcible language of facts, the subordinate recognised his own proper function, as the director of the process of interrogation, but not the interpreter of the answers. To have assumed this office would have been an injurious interference with the instruction efficiently conducted by his principal. We see, then, in this lesson a typical specimen of a process by which the pupil teaches himself, that is, learns without the explanations of the teacher, and in gaining a certain quantity of knowledge gains also the power of acquiring more.

In some such way as this, maintaining the principle, while varying the form of its application, it is presumed that a solid foundation will be laid for a real training of the mind—a training which will be the best preparation for further instruction, not only in science but also in literature.

It will be thought by some who may accept generally the foregoing principles that a needlessly difficult illustration of the theory has been selected, and that it would be better to introduce the subject of mechanics by taking for the first lesson simple levers, &c., and so proceeding from the simple to the more complex—by beginning, in short, at what is usually called 'the beginning.' The general reply to this objection is (1) that the investigator, inquiring into a new science, strictly speaking, does not know what the beginning is, and cannot, therefore, commence with it—and (2) that the fundamental point in the teaching here recommended is that it requires the pupil to be considered as an investigator. In other words, the process

is analytical, not synthetical, and the pupil a student of inductive, not of deductive philosophy. His business is to get an accurate knowledge of the facts before him with the view of framing them, as he proceeds, into general propositions, but the logical co-ordination of these propositions into a system is, while he is yet in his noviciate, no part of his business. As he advances in his course, he will rise to higher and higher generalisations, and see more and more clearly the relation of the principles that he has gained, and at last, when he is master of his subject, will arrive at the beginning—and may, perhaps, write a treatise upon it in which all the propositions which constitute the science are logically arranged. Such a treatise, however, will in no sense represent the process by which he gained his knowledge, but rather its exact converse. Hence, a book of this kind is wholly unsuited to the wants of a young investigator who is to gain knowledge as the author gained it. Such books are, however, on account of their logical completeness, often put into the hands of children by teachers ignorant of the science of education, who do not perceive that the very characteristics which give them their value in the eyes of those who are already educated render them unfit for the use of those who are learning how to learn. It is hardly too much to say that scientifically constructed school books, whatever be their intrinsic merit as compendiums of knowledge, ought to be reckoned among the hindrances, not the aids to early education, and indeed that their real fitness for their purpose is in the inverse ratio of their logical completeness. The knowledge displayed in them may be accurate, the propositions they present unimpeachably expressed—both the matter, in short, and the manner admirably adapted to the prepared mind—and yet they may be, and often are, wholly unsuited

to the mind under training. The food is of the best quality, and is artistically cooked, but it is so concentrated that the youthful stomach cannot possibly digest it. The purveyor in this case is surely somewhat to blame for arrangements ending in such results. The fact is that he has not truly understood the nature of the apparatus which he was directing, and nothing short of a radical change of plan will enable him to correct his error. What this radical change should be has been already indicated.

It appears, then, that scientifically constructed treatises which begin at the beginning—a beginning which is really the end of the investigator's labours—are unsuited to the wants of a child who is to be himself an investigator, and who, in pursuing his process of self-instruction, can only advance from the concrete to the abstract, from particulars to generals, from instances to rules, and who, moreover, has no choice but to advance from the whole to the parts, and then conversely from the parts to the whole. This is in fact Nature's method. She does not commence with the elements—with A B C. She supplies no grammar of the senses. She teaches language by giving whole sentences or whole words, and physics, by presenting wholes, aggregates, or complex facts, and stimulating the analytic faculty to resolve them into their parts or individual phenomena. The justification, then, for beginning the instruction in mechanics by a machine rather than by the elements of which it is composed, by concrete facts rather than abstractions, is seen to be inherent in the nature of the process recommended. If the child is to investigate facts at first-hand, we must imitate Nature by giving him something to investigate which will exercise his analytical powers; something divisible into parts or elements—which,

after due recognition as individual elements, will be traced in the composition of other wholes. On the same principle, if he is to learn to frame general propositions himself, he must commence by knowing the facts which they are to express—that is, by induction of particulars. But this practice in forming inductions of his own will be a powerful aid to his understanding the inductions of others founded on the same or similar facts, and will moreover prepare him for proceeding in due time, conversely, from general propositions to facts by the method of deduction.

Whether such lessons in mechanics as have been suggested should follow or accompany Miss Youmans's 'Lessons in Botany,' or whether any other subject involving the notion of forces should be taken instead of mechanics, are questions which must be left to the judgment of the teacher.

Finally, it should be carefully noticed that the spirit of these remarks on elementary teaching will not have been appreciated unless it is fully understood that the change proposed is fundamental—even revolutionary.[1] It is intended to supersede the didactic, telling, explaining, condescending method which has long prevailed, by one in which the child's own intellect is recognised as the prime mover, and the exercise of his powers of perception and reasoning as the only means by which knowledge which can be truly called his own, is to

[1] 'The principle of connecting education with the laws of nature is radical, and is, as yet, little appreciated, and still less worked out. When admitted and carried into practice, it must revolutionise educational procedure, and is, I believe, the only sound foundation for the education of the future, and the only method which can bring education into consonance with the method which has been so successful in scientific investigation.' From *a MS. lecture, one of a course on the Theory and Practice of Education, now being delivered by Mr. Lake, of the College of Preceptors, at the North London Collegiate and Camden Schools for Girls.*

be gained; by a method, in short, of self-teaching, under superintendence—a method which is rather the learner's than the teacher's.[1] The didactic method has had its day, and we see its results, which are generally 'a farrago of facts partially hatched into principles, of exceptions claiming equal rank with rules, of definitions dislocated from the objects they define, and of technicalities which clog rather than facilitate the operations of the mind.'[2] It is not too much then to say that this method quenches instead of quickening mental development. It does not give children credit for the powers they possess, and therefore fails to elicit them. It has nothing in common with that which Burke, in a well-known passage, characterizes as 'incomparably the best,'[3] and which recognizes even the

[1] Very interesting illustrations of this kind of teaching may be seen in Mr. Wilson of Rugby's description of his method of making a class 'teach themselves' physical science (*Essays on a Liberal Education*, p. 281), and in Professor Tyndall's description of the experiments at Queenwood College, in which he got his pupils to 'find out Euclid' for themselves; a process by which they gained what he calls 'self-power,' and learned geometry as a 'means and not a branch of education.'—*Lecture on the Study of Physics, delivered at the Royal Institution*, pp. 202–204.

[2] From a paper on 'The Correlation of Learning and Teaching,' read by the editor at one of the evening meetings of the Social Science Association. Numerous other illustrations and arguments bearing upon the general subject may be also found in his three lectures 'On the Science and Art of Education, and Educational Methods,' published by the Council of the College of Preceptors.

[3] 'I am convinced that the method of teaching [or learning] which approaches most nearly to the method of investigation is incomparably the best; since, not content with serving up a few barren and lifeless truths, it leads to the stock on which they grew; it tends to set the reader [or learner] himself on the track of invention, and to direct him into those paths in which the author [or investigator] has made his own discoveries.' —*On the Sublime and Beautiful*. It would be curious to enquire how many English teachers, even those who have acknowledged the general truth of this remark, have ever practically applied it.

youngest child as an investigator, who has only to be set on the right path, and to be competently directed, to find out truths for himself.[1] It cannot, therefore, be a means of that training of vital forces which, in the case of every human being, as an organism characteristically endowed with will, must, under competent direction, be ultimately wrought out by himself.

The great principles, in short, (1.) that knowledge is acquired by investigation, through observation and experiment, and (2.) that the acquisition of it in this way, at first hand, constitutes the best training of the youthful mind, are seen to be in direct opposition to that which assumes the incapacity of the child to learn except by means of the direct communication of the teacher's knowledge, accompanied by the teacher's explanations and tellings, and which therefore supersedes and neutralizes the most fruitful employment of the child's faculties. That only is to be considered a fruitful employment of the mental faculties, and as answering the true ends of education, which leads to enlargement of mental view, to the sharpening of the perceptive faculties, to the formation of habits of observing and investigating, to the strengthening of the memory, and generally to the development of intellectual power, not only as an object in itself, but as a basis for moral and religious character.

[1] 'Qu'il (the child) ne sache rien parce que vous le lui avez dit, mais parce qu'il l'a compris lui-même; *qu'il n'apprenne pas la science, qu'il l'invente.*'—Rousseau, *Émile.*

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